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The Protestant Ethic Effect: A Multiple Dependent Variable Analysis

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THE PROTESTANT ETHIC EFFECT:
A MULTIPLE DEPENDENT VARIABLE ANALYSIS

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INTRODUCTION

When an organism is allowed to choose between working for food or receiving "free" food, what will its decision be? For years such a question would have been addressed within the framework proposed by Clark Hull (1943): the organism would choose the alternative requiring the least amount of effort and eat the free food. However, several recent investigations have cast doubt on the generality of this law of least effort. Typically these studies have involved training organisms to respond for a reinforcer, defined as a stimulus that increases the probability of a response (Hilgard & Bower, 1966), and subsequently allowing them to choose between continuing to respond or obtaining the same reinforcer from a free supply. A majority of these experiments have reported that under certain conditions organisms continue to "work" for reinforcement rather than "freeload." As a result of these observations, the labels "contrafreeloading" (Taylor, 1972) and "Protestant ethic effect" (Singh, 1972; Metze & Craig, 1973) have been applied to this phenomenon. The general aim of this thesis is to contribute to the understanding of this behavior through a review of relevant literature and through experimental investigation of heretofore unresearched variables.

REVIEW OF THE LITERATURE

Basic Studies

An early report suggesting that some animals choose the more laborious of two alternatives leading to the same external reinforcement was provided by Havelka (1956). Investigating "problem seeking" behavior in rats, he allowed animals to choose, after familiarization through training, between two different routes to get to food. One route was short and direct and always in the same location while the other, "variable" goal, involved longer, more complicated pathways with the food location varied from trial to trail so the animal had to search for it. The 50 rats in the study were divided almost equally among three preferences; about a third of the animals chose the fixed goal with the short route on most of the trials, another third exhibited a clear preference for the variable goal, and the remainder showed no preference and followed each route about the same number of times. The experiment further revealed that the group that chose the variable goal began to switch to the shorter route only when the reinforcement in the variable situation was fixed at one location. Havelka suggests that there is an "intrinsic reward" involved in problem seeking for the variable goal choice group but offers no interpretation of the large

variability among subjects (Ss) that was observed.

Jensen (1963) conducted the first reported investigation relating specifically to the problem of whether or not rats "prefer" to work or freeload. Following 10 days of a 23 hour food deprivation schedule, 200 rats were given one dispenser training day then one barpress training day in a Skinner box. The Ss were divided into six groups after either 40, 80, 160, 320, 640, or 1280 reinforced responses. In the choice situation a dish containing 250 food pellets was placed inside the operant chamber near the wall opposite the bar location. Jensen reported a general linear trend indicating that the more previous reinforced responses the Ss had the more likely they were to barpress in the choice test. All groups pressed for a portion of their food in the choice but only the group that received 1280 prior rewarded pressed responded for considerably more than half of their food when free food was present (about 75 per cent). It was suggested that barpressing has an "intrinsic appeal" for rats as shown by the fact that all Ss pressed for some of their pellets rather than "...using a less effortful operant or a better established operant that would lead to an equal or greater amount of food per unit of time [p. 451]."

Three studies employing a runway as the experimental apparatus have been reported. Stolz and Lott (1964) trained male rats to traverse an eight foot long alley

for one 15 mg. food pellet. The Ss were trained to a criterion of a median latency of four seconds from the start box to the goal box for 11 trials. These trained Ss persisted in running to the goal box for the one pellet on test days when a pile of food pellets was placed halfway down the alley prior to each trial. Untrained rats ran only to the pile of food in the middle of the runway and ate there, but the experimental group continued to run over this food even when the pellet in the goal box was omitted.

Using a runway to investigate the effects of number of prior reinforcements on behavior with free food presentation, Leung, Jensen, and Tapely (1968) reported results opposite of what Jensen (1963) had found using a Skinner box. They trained two groups of 60 rats each for 75 and 285 trials respectively using a single 45 mg. pellet of food as a reinforcer in the goal box. Following completion of training days, 300 pellets were placed in the start box for the next trial. These researchers found that the more reinforced trials prior to the introduction of food in the start box the more the animals "freeloaded" before running the alley. They suggest that different activities result in varying amounts of "intrinsic appeal" for the animal. Thus, performance in a runway might be expected to result in different preferences than in a Skinner box. In an attempt to compare the effects of free food introduction in the runway directly with the Skinner box, Jensen, Leung, and Hess (1970) trained three

groups of rats with either 0, 40, or 285 rewarded trials in a four foot runway and three other groups with 0, 40, or 285 rewarded barpresses in a Skinner box. On the test day a dish containing 300 pellets was introduced in the Skinner box on the side opposite the bar and a dish with the same number of pellets was placed inside the start box for the runway Ss. Previous reports were supported by the results which showed that the more reinforced trials the animals had in the Skinner box the less free food they consumed in the choice, and the more reinforced trials the runway Ss had been exposed to the less running they did. "Intrinsic appeal" is again suggested as the interpretation with the authors concluding that evidently barpressing provides more of the appeal for operant performance than running down an alley. Although these data may offer some limited insight into the problem it is doubtful that the running response and the barpressing response could be equated for direct comparison as these experimenters did.

Neuringer (1969) was the first to report that the Protestant ethic effect could be demonstrated in animals other than the white rat. He trained two pigeons to peck a lighted disc in an operant chamber for a five second period of access to grain. After seven days of this training a free food cup was filled with grain and placed inside the chamber for 15 days. Neuringer found that both pigeons continued to respond to the disc for most of their

food even though they had access to free grain. The study was replicated with two rats, with the exception that the manipulandum consisted of a bar to press and the reinforcer was food pellets, and the same trend was observed with the Ss barpressing for a majority of their food.

One attempt has been made to demonstrate the phenomenon with still another species, namely the cat. Koffer and Coulson (1971) trained cats to press a metal plate for three seconds access to a 0.8 ml. mixture of water and cat food. After stabilization of responding in daily one hour sessions, which varied from five to 15 sessions, the animals were allowed to choose between responding or eating from a free food dish containing 200 ml. of the same mixture. The results indicated that the cats strongly preferred to consume free food rather than work, and in most instances the Ss ate all the free food before responding. Any conclusions drawn from this study must be regarded with caution, however, due to varying experimental backgrounds of the cats. Of the six animals used in the study two had no prior experimental experience, two had received training on intermittent reinforcement schedules six months prior to this study, and two cats had cannulas implanted in their midbrains.

Studies Related to Reinforcement Schedule

All of the research revieved thus far has involved training on a continuous reinforcement (CRF) schedule, ie., following each appropriate response the animal receives

reinforcement. Several studies have investigated the effects of using other reinforcement schedules, such as fixed ratio (FR), where reinforcement only occurs following a predetermined number of responses. Carder and Berkowitz (1970) allowed rats to eat from a free food dish for three days then trained them to barpress for food pellets on a CRF schedule in 75 minute sessions for six days. The next two days the bar remained active and a dish of free food was introduced inside the chamber. The animals were then required to perform on an FR-2 schedule (one reinforcer per two barpresses) followed by two more days testing with free food available and the bar remaining programmed on the FR-2 schedule. The rats were then given two FR-10 training sessions and tested on this schedule with free food present for two more sessions. Finally, the animals were tested for two more sessions with the original CRF schedule operative and with the free food dish filled. The results indicated that the rats exhibited a clear preference for barpressing on the CRF and FR-2 schedule, but dramatically switched to the free food when required to perform on the FR-10 schedule. These results suggested that "intrinsic appeal" evidently does not fully account for the Protestant ethic phenomenon in rats. If the rats "intrinsically" preferred to press the bar as Jensen (1963) had argued then why should the schedule influence the activity? Evidently the variables associated with receiving and consuming the food influenced the be-

havior since it began to break down under the more demanding schedule.

It has been suggested that the Carder and Berkowitz (1970) data may have been confounded because the animals probably did not consume as much food per session during the FR-10 training days and therefore were "hungrier" on subsequent test days than on test days following the CRF or FR-2 training days (MacDonald, 1970). Carder (1970) replied to this criticism by reporting that Ss earned about the same amount of food during the FR-10 sessions as they had in the FR-2 and CRF sessions, therefore, he concluded that work demands were not confounded with hunger in the study.

In a further extension investigating the effects of various reinforcement schedules, Neuringer (1970) found that pigeons would continue to peck a disc for grain rather than eat free grain if the ratio schedule was less than FR-5 but did not respond if the ratio was greater than FR-10. However, when a variable interval (VI) schedule was used, where Ss were reinforced for responding on the average every one minute, he reported that pigeons responded more than 40 times for each reinforcement while free grain was present. In this experiment Neuringer trained three animals to respond to the lighted disc on the VI-one minute schedule for 15 sessions. On test days the Ss were permitted to consume free food before the disc was activated. When the disc light came on the pigeons continued to eat free food for a few minutes then turned

to the disc and responded for reinforcement for most of the duration of the session. Although Neuringer reported that Ss responded for grain rather than eat the free grain under such a demanding schedule, he conceded that all pigeons in this experiment had "considerable prior experimental experience," therefore the results must be considered only tentative and inconclusive.

Effects of differential FR training schedules were investigated by Singh (1970). He trained three groups of rats to press a lever for food pellets on schedules of FR-1 (CRF), FR-3, and FR-11 respectively. The apparatus and training procedure employed were considerably different from previous reports and warrant description because some questions regarding the Protestant ethic behavior are clarified by this study. Considering Hull's (1943) concept of habit strength, which along with drive directs behavior, previous studies may be critized because the habit strength for barpressing may be greater than eating free food due to the continued number of successive training sessions prior to the introduction of the free food. Singh attempted to equate habit strength for responding for food and eating free food by randomizing work days and free days throughout training sessions. The apparatus was a rectangular chamber divided into two equal compartments. One compartment was the work side for each S and the other was the free food side. An equal number of Ss worked on each side and received free pellets in

the opposite compartment. The Ss were reinforced on the free side one pellet at a time at a rate equal to that determined by responding on the work side the previous day. After 10 days of such training on the appropriate schedule, with half the rats final training day being a work day and the remainder a no-work day, the animals were tested for preference for four days. During testing the wooden partition that had divided the two compartments and prevented the Ss from crossing to the other side was removed. Each rat was placed in the middle of the apparatus and the number of reinforcements obtained on either side was recorded along with number of times the S switched from one side to the other. Regardless of the training schedule, all groups obtained significantly more on the work side, however, than both of the two groups that had been trained under the more stringent schedules.

Evidently, the evidence for contrafreeloading that had been accumulating was not due to an obvious artifact. The Singh (1970) study, in addition to ruling out greater habit strength for responding, showed that the responses emitted under experimental conditions were due to no obvious preference related to number of pellets received at a time. It will be recalled that in all previous studies the free food was introduced in large quantities in a single dish. The animals could possibly have had some preference for receiving one pellet at a time as

they receive for a barpress. However, Singh's data indicated that even when the free food was dispensed one pellet at a time the animals still chose to respond. It was further considered that the rats may possibly have continued to respond because in each session the rate of free food delivery was determined by the response rate of the previous day. Therefore, the Ss could press at a higher rate on the work side on subsequent days and receive reinforcement more frequently than on the no-work side. To test this hypothesis another experiment was undertaken in which rats were trained in the same manner as the first study except that a fixed interval (FI) schedule was used, where the first response after each 30 second interval was reinforced. On the free side a pellet was dispensed every 30 seconds. Thus, in choice testing the animals could not possibly receive pellets at a faster rate on the work side than on the no-work side. Singh found that rats still showed a strong preference for the work side in the choice test. He conducted a third experiment similar to the previous two except that in the choice testing pellets were delivered at a rate 12.5, 25, or 50 per cent faster on the free side than on the work side. Here he found that the 12.5 and 25 per cent groups preferred to respond while the 50 per cent group ate more from the no-work side.

Recent Studies Emphasizing Conditioning Variables

For approximately the last three years research directly related to the Protestant ethic effect has shown a trend to place the phenomenon in perspective in relation to established conditioning principles. Literature reviewed above involved for the most part an attempt to demonstrate the existence of this responding preference or to test its durability through training on a variety of reinforcement schedules. The research reviewed in this section generally reflects acceptance of the contrafree-loading effect and attempts to order this phenomenon in relation to a wide range of conditioning variables. The present emphasis is not just on demonstration or manipulation of schedules but involves evaluation of variables such as deprivation schedule, satiation, extinction, and secondary reinforcement.

In an attempt to characterize some factors influencing responding in the presence of free food, Davidson (1971) trained four rats to press a bar for 45 mg. pellets on a multiple schedule of reinforcement. When the chamber light came on presses were reinforced on an FR-10 schedule. Following reinforcement the chamber darkened and presses were ineffective for pellet delivery. Each session lasted until the animal had 60 reinforcements and the training continued for 56 daily sessions. Following training a free food cup filled with pellets was placed in the chamber. Davidson found that in the choice situation

about the only time the animals consumed free food was in the time-out periods when the light was off and the bar was ineffective. When the light came on signalling the FR component the rats consistently returned to the bar and began pressing. Although the Ss responded at a lower rate than at the end of training sessions, they continued to respond at a steady rate through 87 daily sessions with free food available. Next an extinction phase was introduced where every 10th press operated an empty pellet dispenser instead of delivering the food pellet. Response rates declined rapidly as in normal extinction procedures where reinforcement is withheld. Again, this demonstrated that barpressing is not solely maintained by "intrinsic appeal" but was directly related to receiving the food reinforcer. Davidson further demonstrated that satiation produced differential effects among his Ss. The rats were allowed free access to food for one hour and then placed in the chamber with the same barpress schedule as the other experiments and with free food present. One S responded at a lower rate than in previous testing sessions, two at about the same rate, and one at a higher rate. To further investigate satiation effects on this behavior the Ss were given eight days continuous access to food in their home cages then placed in the testing situation. Two rats responded at about the same rate as in original testing and two responded at a lower rate. Although Davidson indicates that pressing

for food in the presence of free food appears not to be independent of food deprivation level, his results probably do not warrant such a conclusion due to the large between Ss variability that he reported.

Although Davidson's (1971) article suggested that conditioned reinforcement (learned reinforcement also referred to as secondary reinforcement) may play an important role in the work vs. free paradigm, Alferink, Crossman, and Cheny (1973) specifically investigated this variable. They trained two pigeons to peck a disc on an increasingly stringent schedule until they were responding steadily on an FR-300 ratio. After 300 responses the lighted key went dark, the food hopper light came on and the S had three seconds access to grain. Following response stabilization the food hopper was permanently opened so the animals had continuous access to the grain. Six sessions were conducted on the FR-300 schedule with the food open in this manner. The animals responded at a lower rate but maintained a relatively high steady rate nonetheless when they could eat free grain. When the experimenters discontinued light presentation after 300 pecks responding dropped off markedly. When the hopper light was again presented contingent on pecking, the rates of responding increased once again. The pigeons ate whether the light came on or not, so keypecking was not sustained by receiving food alone; the secondary reinforcement of light presentation appeared to be the key variable for maintaining responding.

The introduction of free food during extinction procedures has been shown to suppress responding but not to enhance extinction itself (Enkema, Slavin, Spaeth, & Neuringer, 1972). These researchers trained pigeons to peck a disc for grain reinforcement on a VI-30 second schedule. Following 12 training sessions the response was extinguished by withholding grain contingent on pecking and at the same time making available a cup of free grain. After four such sessions the animals were given seven more extinction sessions without free food. In comparison to controls that were exposed to regular extinction procedures without free food presentation, the experimental group exhibited a marked decrease in responding when allowed access to free grain, but when the free food was removed the animals emitted a higher number of extinction responses than controls. These data, along with the Alferink, Crossman, and Cheny (1973) study, suggest that responding in the presence of free food may depend on the total stimulus complex rather than secondary reinforcement alone. Apparently this behavior is not independent of the reinforcer.

The large number of training sessions used by Davidson (1972), along with the Jensen (1963) data for rats allowed to barpress 1000 times before choice, suggests that a stabilization of responding may be important to produce a work preference. Metze and Craig (1973) trained rats to asymptotic performance, ie. stabilization of

responding approaching a theoretical limit (Chaplin, 1968), prior to choice treatment. They trained four Ss in 10 minute sessions to barpress for pellets then exposed Ss to a choice of pressing or eating from a free food dish. Although all rats continued to press at relatively high rates and the group average indicated a preference for working, two of the animals ate more of the free pellets. The animals were then given three additional days of barpressing as in training then observed in choice for 22 more days. Three of the animals consumed a large majority of their food during these sessions from the free dish. The fourth S responded at an extremely high rate eating very few free pellets and continued to do so for 40 days. These data cast doubt on asymptotic performance as the major criterion for observation of the work preference phenomenon. Differences in design may account for these results; for example, Metze and Craig (1973) used 10 minute training and testing sessions which were shorter than previous reports. Such variables in design differences need to be investigated and replicated before sound parallels can be drawn between studies.

A few studies have been conducted dealing with the comparison of food and water reinforcement within the work-freeload setting. In one such study eight rats were trained to barpress for a 10 per cent sucrose liquid solution and six Ss were trained to press for plain water (Carder, 1972). Both groups were then tested for two days

with the appropriate solution available freely in one bottle and contingent on responding in another. The sucrose group earned 83 per cent of their total fluid while the water group earned only 26 per cent. Carder suggested that much of the rats history in food getting behavior involved manipulation whereas water consumption did not, which may explain the difference in choice. An extension of the original experiment was conducted in which the eight sucrose rats were exposed to increasing concentrations of quinine in their sucrose solution. The Ss showed a decline in preference for pressing for the bitter liquid and drank more of the same solution from the free bottle. When the regular 10 per cent sucrose was reintroduced, six of the eight animals reverted back to responding for the reinforcer. The author suggested that reinforcers of higher quality generate more "behavioral energy" resulting in more barpressing for the preferred solution.

Carder's (1972) finding that rats respond relatively little for a water reinforcer with free water present was confirmed by Taylor (1972). Twenty-five rats were placed on a 23 hour water deprivation schedule then trained to barpress for water on a CRF schedule. Ss pressed in 20 minute per day sessions until 1000 reinforced responses had been made. After the 1000th response the bar was covered and free water was introduced

on the opposite side of the chamber. For the next 15 days Ss were allowed to choose between responding for water or drinking the free water. The animals consistently consumed around 90 per cent of their total liquid intake from the free drinking bottle throughout the choice sessions. In the same study a "replication" of Jensen's (1963) experiment was reported with opposite results from the earlier experiment. Rats were trained to press for food pellets with the same procedure described for the water study described above. The choice test was also conducted in the same manner and Taylor found that the Ss preferred the free food for all but the first two of 15 sessions. A comparison of this study and Jensen's, however, indicate sufficient descrepencies to doubt that Taylor's investigation should be labeled a replication. Jensen's rats that were allowed to make 1000 reinforced responses during training made 40 reinforced responses on the first day, 120 on the next two days, and 160 on the last nine training days. On the choice day they made 40 reinforced responses prior to introduction of free food and subsequently received a large majority of their food by pressing. In contrast, Taylor's rats were trained in time restricted sessions, ie. 20 minutes per day, until a total of 1000 reinforcements had been received. Additionally, after completion of training sessions, Taylor allowed his animals to consume only free food in the chamber with the bar covered for one day before choice testing.

Then the choice test was made the following day with no reinforced responses allowed prior to free food introduction; whereas, Jensen's rats made 40 reinforced presses before free food introduction. These are sufficient differences in manipulation of variables to suggest that the original Jensen design had not been replicated at all.

An interesting addition to the comparison of water and food reinforcers has shown that rats may emit a greater number of responses under the water condition in a choice situation than under the food condition (Knutson & Carlson, 1973). Following acquisition of a barpressing response six rats were trained in 30 minute sessions for five days on a CRF schedule for food pellets. Using similar procedures another group of six Ss was trained to barpress for water reinforcement. The results showed that during three choice test days the water group responded more than the food group. These results are difficult to place in perspective in light of previous data that showed rats continued to emit responses at a high rate when using food reinforcement and relatively lower response rates when using water (Carder, 1972; Taylor, 1972). Unfortunately, Knutson and Carlson failed to report amount consumed at each location in their study for either condition, so it is possible, though unlikely, that a higher percentage of free reinforcement was consumed in the water condition than in the food condition even though more responses were reported for the water group. Here again replication is in order with finer analysis through measurement of

more appropriate dependent variables.

The Davidson (1971) study previously described suggested that barpressing in the presence of free food might vary with different degrees of food satiation; a subsequent investigation revealed that the phenomenon is directly related to number of hours of food deprivation (Tarte & Snyder, 1972). In this study 28 rats were allowed to consume 45 mg. food pellets from a dish for an hour per day for three days then trained to barpress for pellets for six additional days. Following the training days the animals were assigned to one of seven groups and were deprived of food 0, 12, 24, 36, 48, 72, or 92 hours before preference testing began. For the test sessions the bar remained effective in producing reinforcement as in training and 300 pellets were placed in a dish on the other side of the apparatus. Animals were placed inside the apparatus and were not allowed any prechoice barpresses or free pellets. A positive linear trend was evident with animals responding for more of their food the longer they had been deprived. The mean percentage of total food consumed by barpressing ranged from 29.55 for the group not deprived to 93.50 for the group deprived for 72 hours. A noteworthy observation of this study, as with much research in this area, was the wide variability within groups. For example, in the group not deprived the amount of food obtained by barpressing in the choice session ranged from five per cent to 95 per cent. With the groups

deprived the longest, however, this variability diminished with the Ss pressing for almost all of their food and appearing "stimulus bound" to the bar.

One variable that has differed widely among designs is whether or not the Ss are allowed to make any prechoice barpresses on test days. Jensen (1963) allowed his animals to make 40 reinforced barpresses prior to choice testing, Carder and Berkowitz's (1970) animals made 25 prechoice presses, Tarte and Snyder (1972) allowed no prechoice responses, and Taylor (1972) permitted animals to consume only pellets from the free dish the day prior to testing. An analysis of such pretest variables has indicated the importance of prechoice treatment and may account for some conflicting results (Tarte & Snyder, 1973). Rats were trained to barpress for food for nine days then subjected to choice treatment for three sessions. For choice testing the animals were divided into three groups and allowed to make 0, 25, or 50 reinforced responses prior to free food introduction. Regardless of the number of prechoice reinforcements received, all groups preferred to barpress for most of their food during the test condition. These researchers further investigated the influence of equalizing the amount of time eating free food and amount of time spent responding for food prior to choice. Three rats received free food on Day 1 and three others were trained to barpress for food. On Day 2 the first group began barpress training and the second group received the first session of eating only free food.

For eight days both groups alternated between working and eating free food in daily one hour sessions; by the first choice day all the Ss had spent an equal amount of time in free food sessions and in barpress sessions. For five choice days the animals indicated a clear preference for the free food. Through similar procedures, it was observed that rats also preferred free food to responding if the number of pellets received freely and the number received by responding were equalized prior to test days. Eight rats were allowed to consume 100 free 45 mg. Noyes pellets in the experimental chamber (with the bar removed) on the first day. The next two days the rats were trained to press the bar for pellets on a CRF schedule. For the next 14 days, conditions were alternated between free food and work sessions until all animals had taken 1300 pellets in each condition. Four choice sessions revealed that the Ss received the majority of their food from the free dish. For the choice tests, the mean percentages of pellets obtained by barpressing were 16.7, 17.8, 24.8, and 21.2. It was noted that in all these experiments virtually no animal ate about half of their food from both locations but most demonstrated a strong preference for either the free food or the response contingent food.

STATEMENT OF THE PROBLEM

The weight of research supports the existence of the Protestant ethic effect under a wide range of conditions. Several variables appear to influence the degree of work preference observed, including: amount of prechoice training, deprivation schedule, reinforcement schedule, and dispersion of prechoice work and free conditions. As unexplored alternative to explanations offered thus far to account for work preference centers around observations of activity seeking in animals. It has been shown that rats will learn to barpress for a reinforcement of running in an activity wheel (Kagan & Berkun, 1954), and further that rats will run in a wheel longer, the longer they have been confined (Hill, 1956). If animals press the bar in the choice paradigm because of some reinforcement by activity it might be expected that they would also respond if a bar were located near a free food source, or, for that matter, respond to a bar not in proximity to a food location. Furthermore, if there are some "intrinsic appeal" properties for barpressing, responding in such a situation would support this notion.

In addition to exploring any reinforcement by activity the present experiment also tests the degree of work preference by provision of two free food locations and an

assessment of any "stimulus bound" properties resulting from long training histories. For clarification of hypothesis statement and future reference the following locations are designated:

CRF location: food pellet reinforcement contingent on barpressing,

FFB (free food/bar) location: a noneffective bar located beside a dish of free food,

FFO (free food only) location: a dish of free food with no bar near it, and

BO (bar only) location: a noneffective bar with no free food near it.

Specific null hypotheses are:

Hypothesis 1: There is no difference in number of pellets obtained from the CRF, FFB, and FFO locations,

Hypothesis 2: There is no difference in number of barpresses at CRF, FFB, and BO locations, and

Hypothesis 3: There is no difference in amount of time Ss spend at the CRF, FFB, FFO, and BO locations.

It was expected that all hypotheses would be rejected directionally with more pellets being consumed at the CRF and FFB locations, more barpressing at the CRF and FFB locations, and more time spent in the CRF and FFB locations.

METHOD

Subjects

Eight experimentally naive albino rats from the departmental animal colony at Western Kentucky University were used as Ss. The animals, approximately 180 days old at the beginning of the study, were housed in individual cages with water available ad lib between experimental sessions throughout the project. A 12 hour on - 12 hour off light-dark cycle was automatically imposed and temperature was thermostatically maintained at approximately 75° F.

Apparatus

A cylindrical activity chamber (Lehigh Valley Electronics) was modified to meet the requirements of the present experiment. The apparatus was 60 cm. in diameter with a 42 cm. high aluminum wall painted flat black on the inside. The wire mesh floor was sectioned off into equal quadrants and round aluminum bars 1 cm. in diameter and 4 cm. in length were mounted through the floor in three of the quadrants 6.5 cm. from the wall as shown in Figure 1. Circular hard plastic dishes 5 cm. in diameter and 1.6 cm. deep were attached to the floor 4 cm. from the wall. Thus each quadrant was constructed for four different activity locations: CRF, FFB, FFO, and BO. A press on any of the bars produced an audible click on

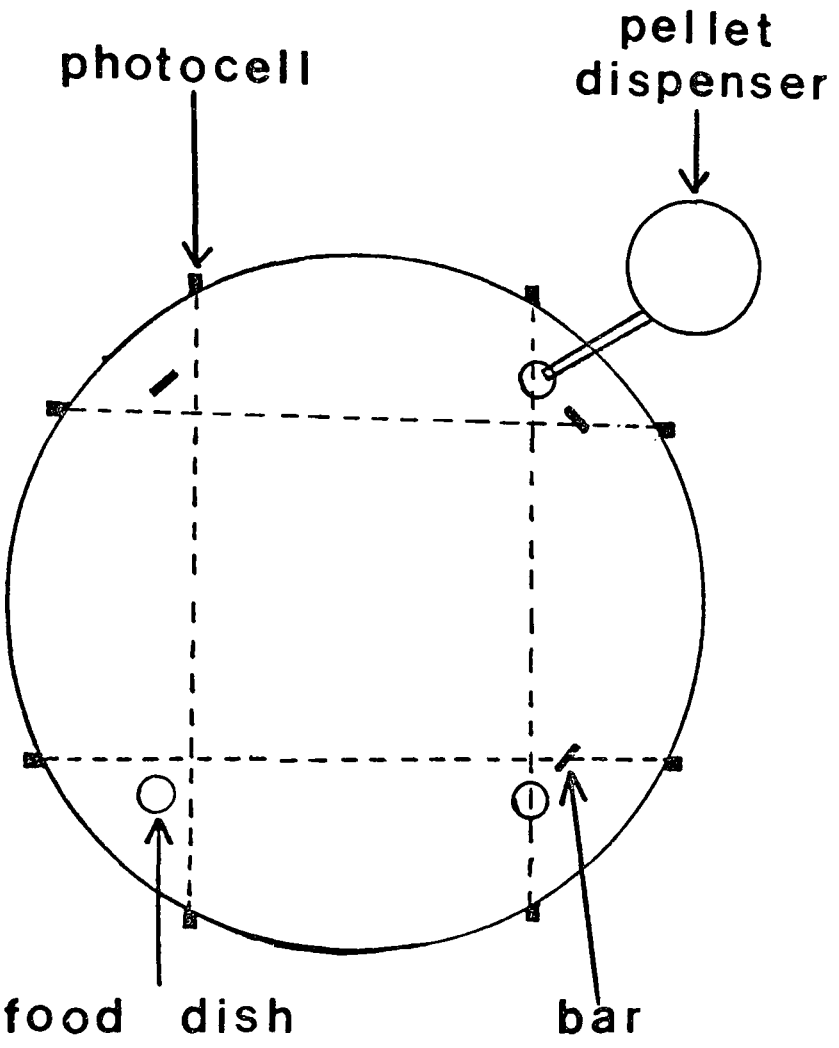

Figure 1

EXPERIMENTAL APPARATUS

a microswitch and activated one of three counters. A response on the CRF bar also activated a pellet dispenser located outside the apparatus that deposited one 45 mg. Noyes food pellet in the dish by that bar. Four sets of photocells were arranged so that when an S was near any location (within 2 cm.) the interruption of two infrared light beams crossing each area would start one of four timers. When an animal left an area the beams were unbroken and the equipment would cease timing. All programming equipment was housed in a separate room; any time the Ss were in the experimental room diffuse overhead lighting was provided and masking noise from a speaker located above the chamber was presented.

Design

A within-Ss design was employed for the experiment. Following acquisition and stabilization of barpress response rate on a CRF schedule, stimulus conditions were manipulated through the addition of free food at two locations. The effect this treatment had on Ss' behavior was evaluated by the following dependent measures: (a) number of food pellets obtained at each of the three food areas, (b) number of barpresses at each of the three bar locations, and (c) amount of time in minutes spent at each of the four locations.

Procedure

Pretraining procedure. The Ss were placed on a 23 hour food deprivation schedule for two weeks then placed inside

the experimental chamber for 30 minutes exploration and magazine training on two successive days. Four days of barpress shaping were then conducted in 30 minute per day sessions. Each S was allowed 30 minutes access to lab chow in its home cage immediately after each session was completed. The free food dishes in the FFO and FFB locations were present but empty throughout pretraining to control for any novelty effect; for the same reasons the bars were present in the BO and FFB locations.

Training procedure. Following shaping sessions the Ss were given 25 daily barpressing sessions in one 20 minute session per day. The number of pellets obtained and number of responses were recorded. The Ss were allowed the same access to food following these sessions as in pretraining.

Choice testing. Ten days of choice treatment were given after the training days with each of the two free food dishes filled with 150 pellets each. The Ss were placed in the center of the chamber approximately the same distance from all critical areas. Each choice session was 20 minutes long and animals were given access to food after each session. Amount of time spent at each location, the number of barpresses at the three bar areas, and number of pellets obtained at the three food areas were recorded for each S.

RESULTS

By the end of training all Ss had stabilized in response rate during the 20 minute sessions and by the last nine days the mean number of presses per day for each S at the CRF bar ranged between 180 and 185 (see Figure 2). During training, responses on the BO and FFB bars were almost nil with no animal pressing either of these bars more than four times in any one session.

In choice testing the animals as a group consistently received a large majority of their total food by barpressing at the CRF bar as shown in Figure 3. Analysis of variance for food obtained from the three locations yielded a significant difference (F (2, 21) = 8.16, $p < .005$) and a Duncan's multiple range test further showed that amount taken from the two free food dishes did not differ but number of pellets obtained at the CRF location differed from both the free food areas ($p < .01$). Although there was considerable variation both between and within Ss performance across choice test days, Table 1 reflects that only one S obtained less than half (41.6 per cent) its overall total food by barpressing. Table 1 also shows that the majority of animals received a greater percentage of pellets by working on most days and the mean percentage obtained by pressing was greater than 50 on all test days.

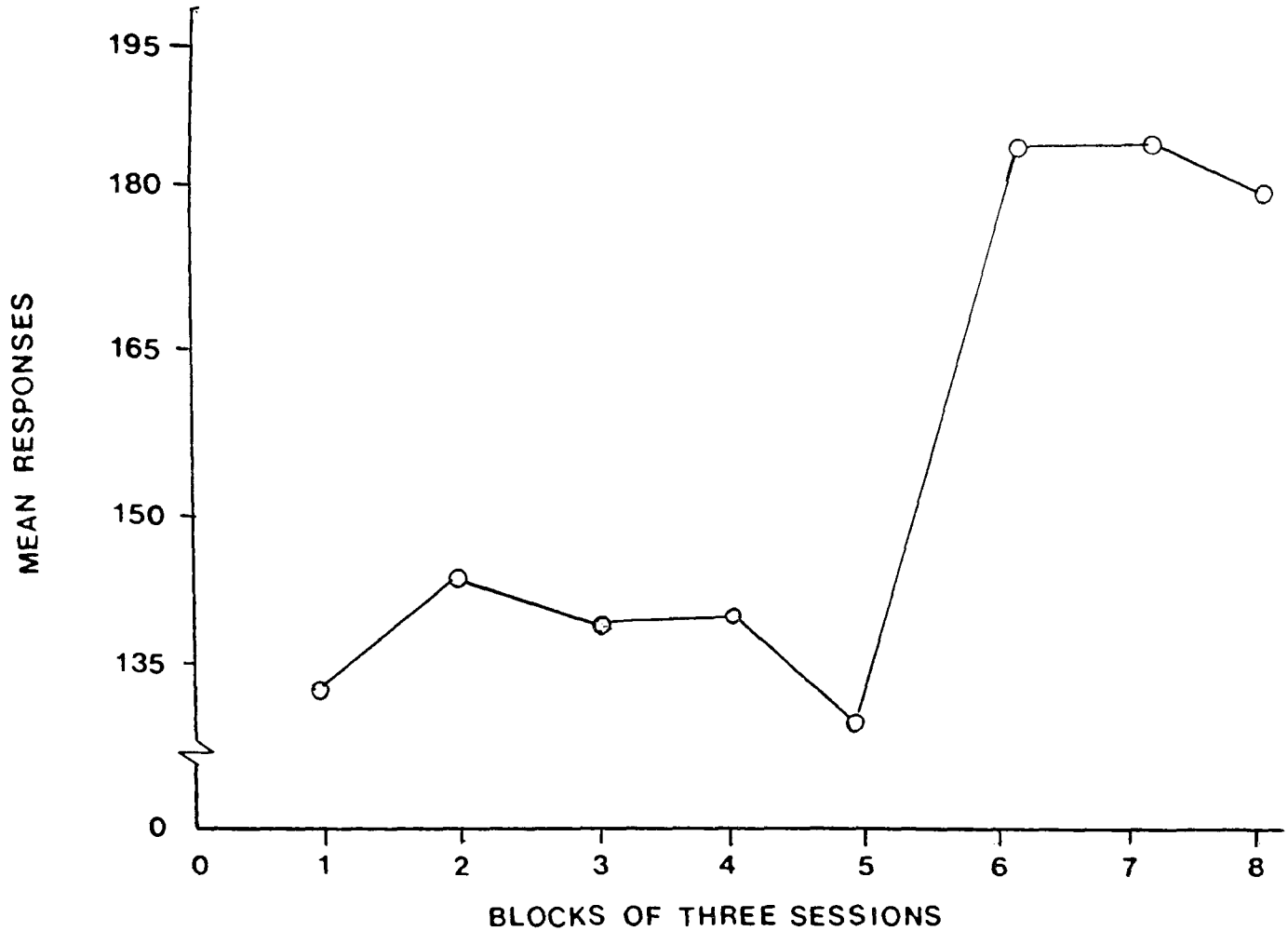

FIGURE 2

MEAN RESPONSES DURING TRAINING

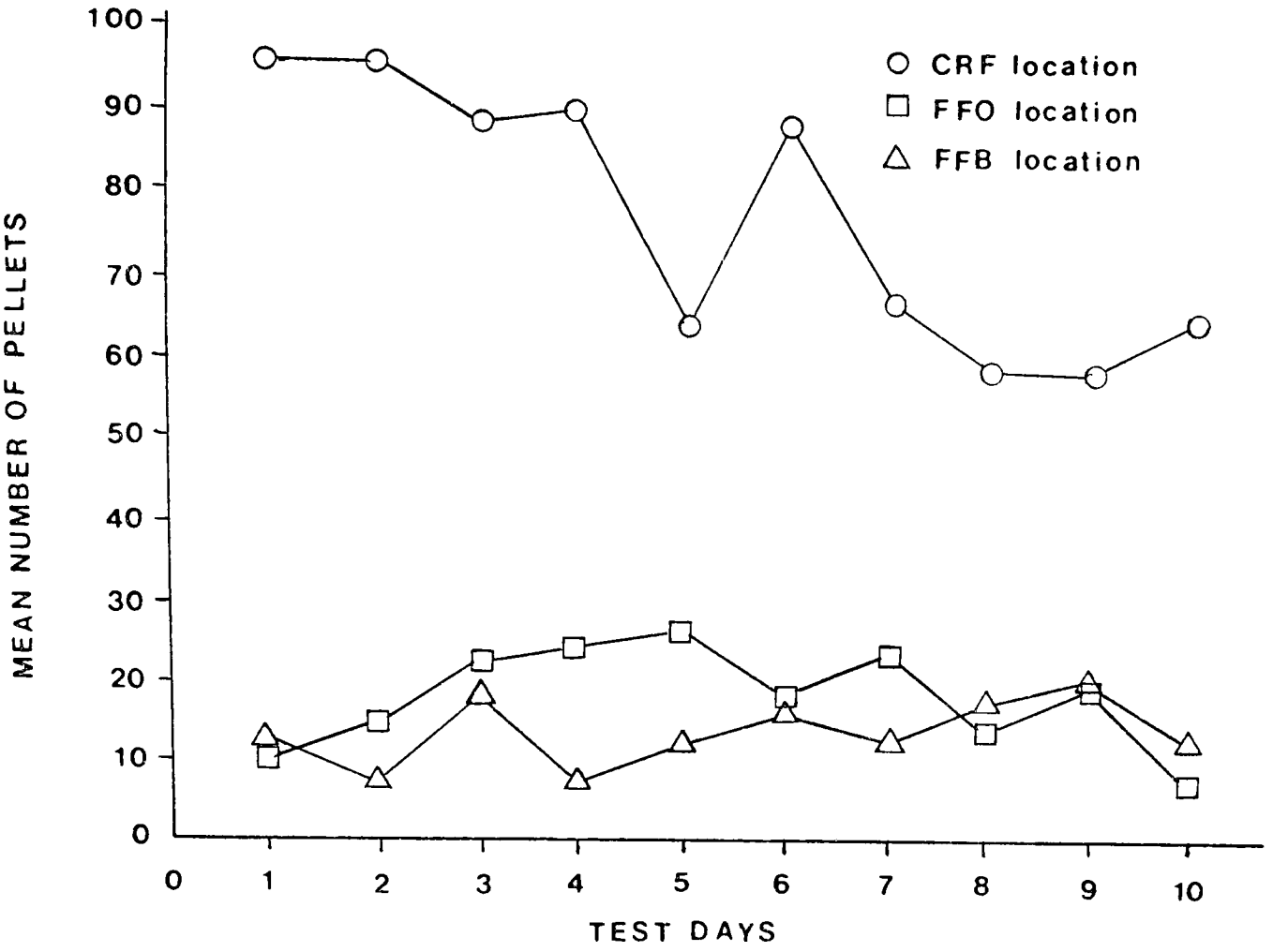

FIGURE 3

PELLETS OBTAINED IN CHOICE

TABLE 1

PERCENTAGE OF PELLETS OBTAINED BY BARPRESSING IN CHOICE

	Test Day										
S	1	2	3	4	5	6	7	8	9	10	Mean
1	86	93	70	86	51	21	18	39	19	63	54.6
2	85	99	98	98	97	97	88	94	90	78	92.4
3	62	78	51	53	20	76	83	63	60	50	59.6
4	82	96	78	95	92	83	77	56	82	63	80.4
5	79	79	84	95	85	82	68	48	53	90	76.3
6	87	82	83	51	42	88	90	97	63	85	76.8
7	78	57	38	25	42	28	36	67	73	85	58.9
8	83	59	29	45	30	57	39	11	17	46	41.6
Mean	80.3	80.4	66.4	68.5	57.4	74.0	62.4	59.4	57.1	70.0	

As in training very few responses were recorded at the FFB and BO location as depicted in Figure 4. No difference was evident between the number of responses at these two areas on choice days and the number of responses on both bars remained essentially the same as in training. The presence of free food appeared to have an effect on total number of work responses; a difference was noted between total CRF responses for the last 10 training days and the choice days (t (7) = 1.92, $p < .05$).

Figure 5 shows that Ss spent a large majority of total recorded time around the CRF location. An analysis of variance comparing time at the four locations indicated a significant difference (F (3, 28) = 3561.16, $p < .005$) and a Duncan's multiple range test showed that the CRF total time differed significantly from the other locations ($p < .01$) with none of the others differing from each other. At times Ss would get a pellet out of a free dish and back away to eat thus interrupting the timer which may partially account for the extremely short amounts of time recorded for the free food areas. When rats were engaged in working at the CRF bar this behavior was not observed. However, it is emphasized that Figure 5 reflects an accurate representation of relative time engaged in the various activities as confirmed by direct observation. On test days animals generally would spend approximately the first two minutes of the session eating from one of the free dishes then barpress for most of the remainder

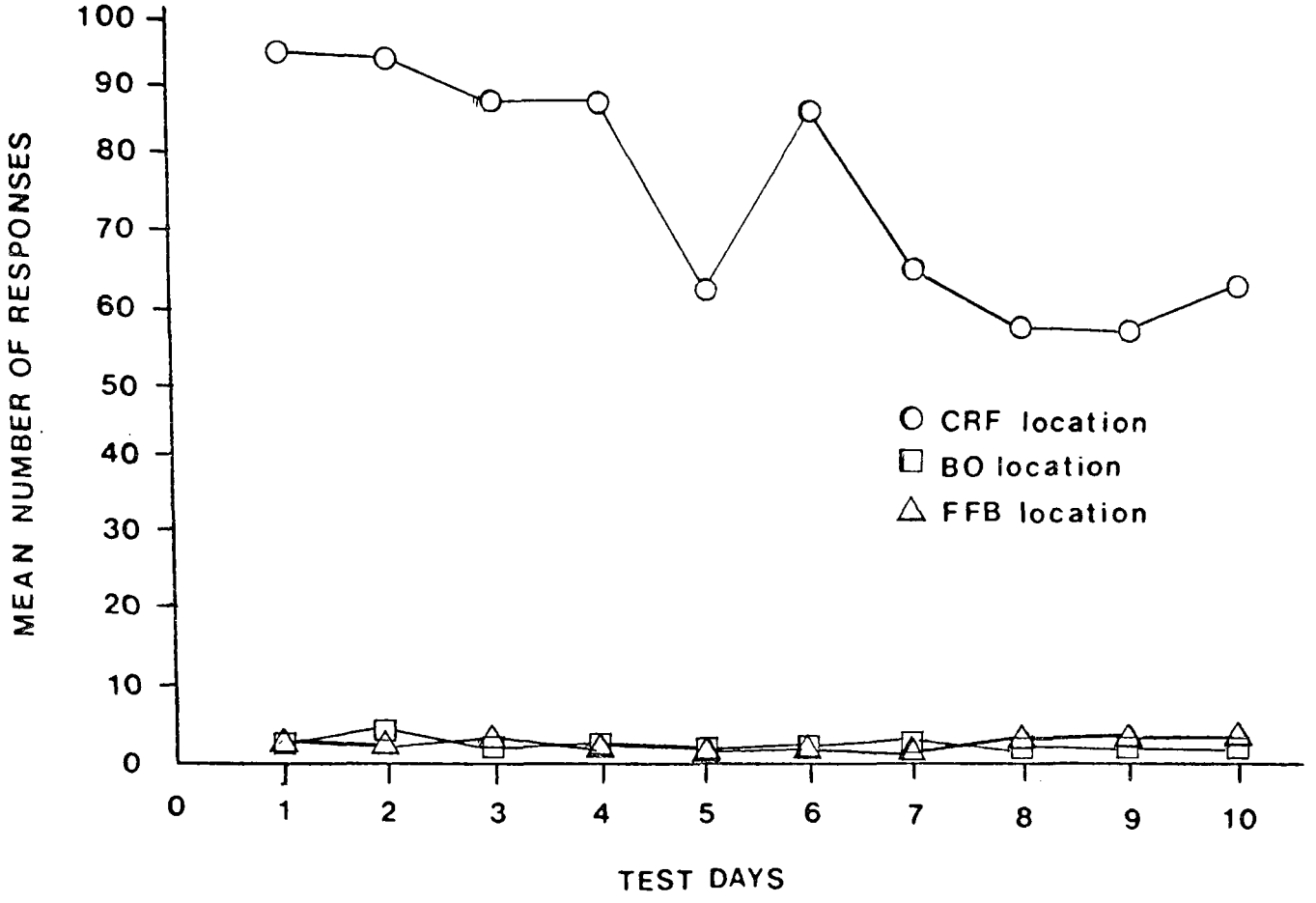

FIGURE 4

MEAN RESPONSES ON CHOICE DAYS

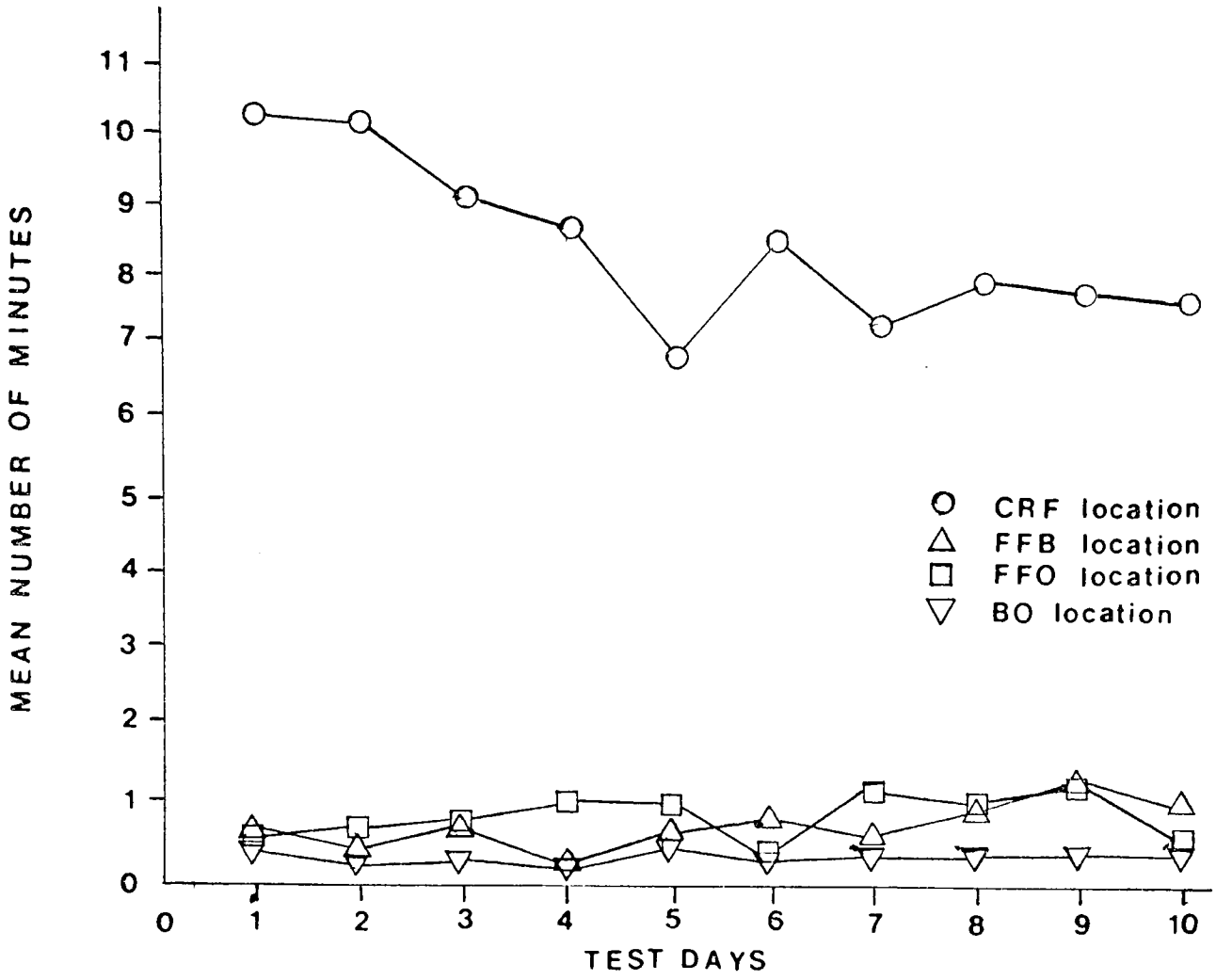

FIGURE 5

TIME AT EACH LOCATION ON CHOICE DAYS

of the session for their food with brief intermittent returns to free food locations. An exception was S Number 2 which immediately began pressing at the CRF bar upon being placed in the chamber and made very few switches to free food locations. It was further noted that on days when Ss consumed a majority of their food from free dishes they usually still spent more time at the CRF location than the free areas combined.

DISCUSSION

The present findings indicate that rats will continue to respond in the presence of free food for a majority of their food. The three original null hypotheses were rejected directionally as the animals spent more time in the CRF area, ate more food there, and pressed the bar more at that location than any of the others. These results along with the accumulating body of literature are at odds with the traditional Hullian least effort hypothesis. That animals would work at all while free food is present conflicts with intuitive conjecture, but when the rats work for the majority of the time and for most of their food simple reinforcement explanations are taxed. Possibly some secondary reinforcement may account for the behavior but obvious factors have been ruled out. For example, until the present experiment, the motor activity of barpressing or auditory feedback from the microswitch could have been considered secondarily reinforcing. Thus, the work preference could be explained in these terms. However, this study shows that this is not the case as the same auditory feedback was produced by two other bars and the same motor activity could be exerted at two other bars but the Ss still responded for their food. The sight and sound of a single pellet dropping into a dish could

also be considered secondary reinforcement, but Singh (1970) eliminated this possibility by introducing the free food by dispensing one pellet at a time and the Ss preferred to respond. Furthermore, Jensen's (1963) original contention that barpressing has some "intrinsic appeal" for rats does not hold up in light of the present data since the Ss pressed very little at the FFB and BO locations. The data indicate that the activity of barpressing is sustained in relation to receiving food as the studies in extinction have suggested.

Tarte and Snyder's (1973) observation that some of their Ss appeared "stimulus bound" to the bar is supported by this study. It should be emphasized, however, that any "stimulus bound" properties are specific to the CRF schedule bar. Rats not only pressed this bar almost exclusively but spent the majority of time around it even when they ate more food from free locations. Evidently they were not attracted solely by the bar but by the composite stimulus properties of the CRF area. These data also suggest that if any activity motivation is involved it is not merely behavior associated with barpressing but the activity of barpressing for food reinforcement. Furthermore, this behavior appears different from behavior reported by others indicating activity motivation in different settings, e.g. monkeys will engage in solving mechanical puzzles (Harlow, 1953) and rats will learn to barpress to gain access to running in an activity wheel (Kagan &

Berkun, 1954; Hill, 1954) contingent on no consumatory reinforcing stimulus. In this experiment barpressing occurred for the most part in relation to obtaining food.

It has been suggested that animals are motivated to actively manipulate their environment and that their general behavior is directed toward controlling and modifying the external world (White, 1959). Experimental support for such a concept has been reported by Kavanau (1967) who found that deer mice will tear down and rebuild over and over again a nest that has been provided for them. They further learn to leverpress on stringent schedules for food, water, to start an activity wheel, and to control light intensity in their cages. Kavanau observed that any opportunity provided for the animals to modify and control their surroundings was repeatedly engaged in. The Protestant ethic effect seems best explained at this time in the same terms. Although rats are afforded free food and an opportunity to engage in the activity of barpressing just for the sake of activity, they prefer to control the process of receiving their food by responding for a pellet at time after this activity has become a part of their repertoire of behavior.

REFERENCES

Alferink, L. A., Crossman, E. K., & Cheney, C. D. Control of responding by a conditioned reinforcer in the presence of free food. Animal Learning and Behavior, 1973, 1, 38-40.

Carder, B. Work demands or food deprivation. Science, 1970, 170, 1229.

Carder, B., & Berkowitz, K. Preference for earned food in relation to free food. Science, 1970, 167, 1273-1274.

Carder, B. Rats' preference for earned in comparison with free liquid reinforcers. Psychonomic Science, 1972, 26, 25-26.

Chaplin, J. P. Dictionary of Psychology. New York: Dell, 1968.

Davidson, A. B. Factors affecting keypress responding by rats in the presence of free food. Psychonomic Science, 1971, 24, 135-137.

Enkema, S., Slavin, R., Spaeth, C., & Neuringer, A. Extinction in the presence of free food. Psychonomic Science, 1972, 26, 267-269.

Harlow, H. F. Mice, monkeys, men, and motives. Psychological Review, 1953, 60, 23-32.

Havelka, J. Problem-seeking behavior in rats. Canadian Journal of Psychology, 1956, 10, 91-97.

Hilgard, E. R., & Bower, G. H. Theories of learning. New York: Appleton-Century-Crofts, 1966.

Hill, W. F. Activity as an autonomous drive. Journal of Comparative and Physiological Psychology, 1956, 49, 15-19.

Hull, C. L. Principles of behavior. New York: Appleton-Century-Crofts, 1943.

Jensen, G. D. Preferences for bar pressing over "freeloading" as a function of number of rewarded presses. Journal of Experimental Psychology, 1963, 65, 451-454.

Jensen, G. D., Leung, C. M., & Hess, D. T. "Freeloading in the Skinner box contrasted with freeloading in the runway. Psychological Reports, 1970, 27, 67-73.

Kagan, J., & Berkun, M. The reward value of running activity. Journal of Comparative and Physiological Psychology, 1954, 47, 59-64.

Kavanau, J. L. Behavior of captive white footed mice. Science, 1967, 55, 1523-1639.

Knutson, J. F., & Carlson, C. W. Operant responding with free access to the reinforcer: A replication and extension. Animal Learning and Behavior, 1973, 1, 133-136.

Koffer, K., & Coulson, G. Feline indolence: Cats prefer free to response produced food. Psychonomic Science, 1971, 24, 41-42.

Leung, C. M., Jensen, G. D., & Tapley, R. P. "Freeloading" in a runway as a function of amount of training and type of reinforcement schedule. Psychological Reports, 22, 211-214.

MacDonald, L. Work demands or food deprivation? Science, 1970, 170, 1229.

Metze, L., & Craig, J. R. The Protestant ethic effect: Do rats prefer to work? Unpublished manuscript, Western Kentucky University, 1973.

Neuringer, A. J. Animals respond for food in the presence of free food. Science, 1969, 166, 399-401.

Neuringer, A. J. Many responses per food reward with free food present. Science, 1970, 169, 503-504.

Singh, D. Preference for bar pressing to obtain reward over freeloading in rats and children. Journal of Comparative and Physiological Psychology, 1970, 73, 320-327.

Singh, D., & Query, W. T. Preference for work over "free-loading" in children. Psychonomic Science, 1971, 24, 77-79.

Singh, D. The pied-piper vs. the protestant ethic. Psychology Today, 1972, 5, 53-54.

Stolz, S. B., & Lott, D. F. Establishment in rats of a persistent response producing a net loss of reinforcement. Journal of Comparative and Physiological Psychology, 1964, 57, 147-149.

Tarte, R. D., & Snyder, R. L. Bar pressing in the presence of free food as a function of food deprivation. Psychonomic Science, 1972, 26, 169-170.

Tarte, R. D., & Snyder, R. L. Some sources of variation in the bar pressing versus freeloading phenomenon in rats. Journal of Comparative and Physiological Psychology, 1973, in press.

Taylor, G. T. A limitation of the contrafreeloading phenomenon. Psychonomic Science, 1972, 29, 173-174.

White, R. W. Motivation reconsidered: The concept of competence. Psychological Review, 1959, 66, 297-333.